Solar Thermal Propulsion

Alan Adams/PS05
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Solar thermal propulsion is an advanced propulsion concept that utilizes concentrated solar energy to heat a propellant and thereby produce thrust. This propulsion concept will be used on an upper-stage vehicle with the main application being the transfer of payloads from low-Earth orbit to geostationary Earth orbit. The solar thermal propulsion concept is characterized as having low thrust (2 to 5 pounds force), high specific impulse (800 to 1,000 seconds), and is a much more efficient means of transporting payloads when compared to conventional chemical propulsion systems. Such efficiency will allow for the reduction of launch costs and for the increased competitiveness of the U.S. launch services industry.

MSFC has been involved with the design aspects and feasibility of solar thermal propulsion for the last few years. The initial involvement was a feasibility study conducted by MSFC's Program Development Directorate that provided the evidence that the concept offers sufficient performance gains over chemical propulsion systems, suggesting further detailed study was warranted.

Following that activity, MSFC has entered a cooperative agreement with a solar thermal consortium led by McDonnell Douglas. Part of NASA'S Aerospace Industry Technology Program effort, the Solar Thermal Upper-Stage Technology Demonstration Program, is a simulated integrated, systems-level ground test of a solar thermal propulsion system. MSFC is responsible for the testing of the liquid-hydrogen storage/feed system and the propulsion engine development. In the ground test program, the testing of the hydrogen storage/feed system will be performed at MSFC. These data will then be used as inputs to a test of the concentrator and engine, which will be performed at the Air Force Phillips Laboratory, Edwards Air Force Base. The concept to be tested utilizes an inflatable parabolic concentrator with foam rigidized support struts.

Key technologies associated with solar thermal propulsion include inflatable structures, engine design/fabrication, and pointing accuracy of the solar concentrators. In the solar thermal propulsion concepts being pursued by MSFC, the solar concentrators are inflatable structures made from a thin-film polyimide material, providing a lightweight structure for the vehicle and allowing greater payload capacity. The engine being designed and fabricated at MSFC is utilizing vacuum spray fabrication technologies.

Currently, MSFC is developing a flight experiment to demonstrate the key technologies mentioned above. The experiment will use a deployable Fresnel lens concentrator, an energy storage-type engine, and will be the first major milestone in the development of solar thermal propulsion. The experiment will not, however, perform an orbital transfer. At the successful conclusion of the experiment, a more ambitious flight will be performed, which will be more representative of a full-up upper stage, performing a low-Earth orbit to geostationary Earth orbit transfer. The flight date for the experiment is mid to late 1998. The likely launch vehicle for this flight experiment will be the Delta II launch vehicle.

Sponsor: Office of Space Access and Technology

Industry Involvement: McDonnell Douglas, United Applied Technologies, Thiokol Corporation

University Involvement: University of Alabama in Huntsville